

## 8.0 Environmental Data Collection, Evaluation, and Management

### 8.1 Sampling and Data Collection

The following sections provide detailed instructions for the collection of samples and field data.

#### 8.1.1 Automated Surface Water Sample Collection

The majority of surface water sampling at the Site is accomplished through the use of automated samplers. These samplers operate in an unattended mode, collecting flow-paced composite samples continuously. This section outlines the methodology for flow-pacing the automated samplers according to manufacturer's instructions (see Section 7.1). The following list of assumptions regarding automated sampling acknowledges that monitoring under all potential Site conditions may not be possible:

- For purposes of computation in regulatory reporting, the sample date for a multi-day composite sample will be the date that the composite sample was started. Although this will give the impression that multi-week samples are being reported months late, this convention is consistent with other Site data.
- Successful completion of a flow-paced composite sample is determined by several factors that are evaluated by the sampling team. These include, but are not limited to, the required sample volume for analysis (normally at least approximately 4 liters [L]; see nonsufficient quantity [NSQ] discussion below), equipment failures, off-normal conditions (e.g., emergencies, severe weather, or other *force majeure*), or H&S concerns.
- If sample accumulation is terminated for cause, and sample volume is inadequate for routine laboratory analyses, then no analyses are required, and the sample will not be used in the computation of compliance values. For example, routine laboratory analysis for plutonium and americium currently require 4.0 L. Therefore, samples of less than 4.0 L may be discarded (if necessary) and not used in the computation and evaluation of compliance parameters, but the sample collection must be reported. This requirement may be referred to as the NSQ requirement regarding insufficient quantity of sample.
- Where there is no significant flow, there may be no composite samples completed within a compliance calculation period (see NSQ above). However, flow-paced sampling will continue during dry periods, even though flows may be so low that it may take longer than the required compliance period to fill the composite sample container.
- If no samples are collected during a compliance interval due to a low- or no-flow condition, then no sample result will be available for use in the computation of compliance values, and no such compliance value will be reported for that period.
- Samples collected for RFLMA monitoring must be reported, even if they are not analyzed, and the reason for not analyzing (e.g., NSQ) must also be reported.

#### *Continuous Flow-Paced Composite Samples*

Continuous flow-paced composite samples are collected during all flow conditions. Automated samplers collect grab samples year-round at all times. When a composite sample is removed from the sampler for analysis, the next composite sample starts filling immediately, if flow is available. If the location is dry at the initiation of a new composite sample, the flow meter is

programmed to trigger sample collection at the next available flow period. A composite sample consists of multiple grab samples<sup>15</sup> that are flow-paced. In other words, one grab sample is deposited in the composite sample bottle each time a specified volume of stream discharge is measured by the flow meter. Figure 8–1 is an example of flow-pacing of grab samples every 4,390 cubic feet of stream discharge for a continuous flow-paced sampling event. The chosen flow pace depends on expected stream discharge, the composite volume desired, and the desired composite-sampling period. Details on the method used to determine the desired flow pace are provided below (see “Flow Pacing of Automated Samplers”).

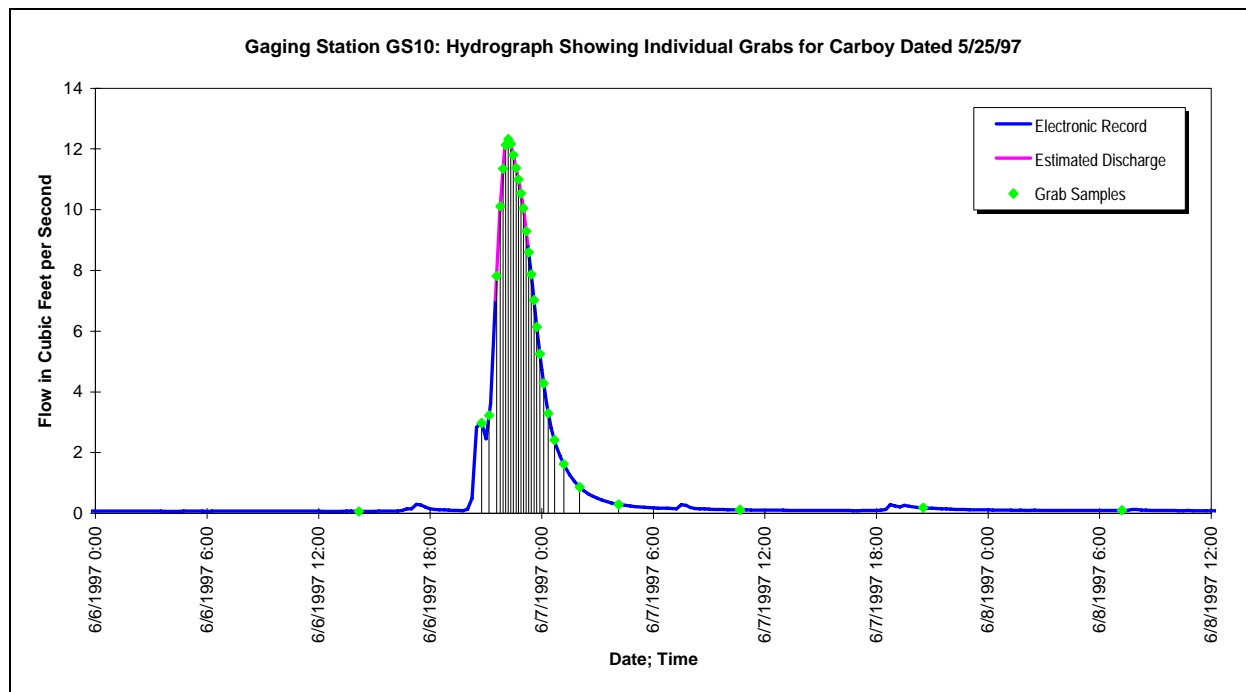


Figure 8–1. Example Hydrograph Showing Continuous Flow-Paced Composite Sampling

Ideally, by flow-pacing composite samples and effectively collecting more frequent grabs during higher flow rates, an analytical result—in terms of concentration (e.g., milligrams per liter [mg/L] or activity (e.g., picocuries per liter [pCi/L])—that is representative of the entire sampling period is obtained. This result can then be used with the corresponding discharge volume to calculate a constituent load and the appropriate compliance values.

<sup>15</sup> The current grab sample volume for continuous flow-paced composite samples is 200 milliliters (mL). This volume was chosen to maximize the number of grabs while achieving adequate repeatability. ISCO® samplers have a sample volume repeatability of  $\pm 10$  mL. Therefore, a volume error of  $\pm 5$  percent can be expected.

## *Flow Pacing of Automated Samplers*

The chosen flow pacing for a composite sample must satisfy the following criteria:

- The composite sample should fill during the specified time period as determined by the targeted sample collection frequencies.<sup>16,17</sup>
- The collected sample volume must be adequate such that the location-specific analyses can be conducted by the laboratory.<sup>18</sup>

The following steps are used to determine the appropriate flow pace for a continuously collected composite sample:

- [1] The location-specific targeted time period for the composite sample must be known. For example, typically four composite samples are targeted for the month of May at GS10.
- [2] The expected discharge volume for the targeted time period must then be calculated using historic flow record.<sup>19</sup> For locations with limited historic flow record, professional judgment, estimations related to basin size, and/or flow record at upstream/downstream locations are used to determine expected discharge volumes.

For example, at GS10 the expected discharge volume for May is 5.48 MG. In order to collect four composite samples for the month, one composite sample is collected for every 1.37 MG.

- [3] The targeted number of 200-mL grab samples for the composite sample is then determined. The targeted number of grabs is set using professional judgment to collect a composite volume between the minimum required sample volume<sup>18</sup> and the maximum volume that can be contained in the sample bottle.<sup>20</sup> This allows for variation in actual measured discharge (from the expected discharge based on historic record), while still collecting the composite sample in the targeted time period.

For example, at GS10 the composite sample bottles can contain a maximum of 22 L, and the minimum required sample volume for complete laboratory analysis at GS10 is 4.8 L. Consequently, the sampler at GS10 is normally paced to collect sixty 200-mL grab samples if the stream discharge volume is average for the target period, resulting in a composite sample volume of 12 L. The actual stream discharge volume would be expected to vary from historical averages. Therefore, composite samples are collected from the field with a total number of grabs varying from 24 (4.8 L) to 110 (22 L).

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<sup>16</sup> Annual composite sample totals are determined by statistically evaluating historical data. Software programs such as Visual Sample Plan<sup>®</sup> (VSP; Batelle Memorial Institute; <http://vsp.pnl.gov/>) are used to determine appropriate sample counts to achieve a level of confidence in the results such that decisions can be made. Annual sample counts are distributed monthly based on historical flow data.

<sup>17</sup> Samples are flow-paced based on average expected discharge rates calculated from historic discharge records. Consequently, samples may fill in periods shorter than the targeted period when flow rates are significantly higher than normal. Similarly, samplers may not fill during the targeted period if flow rates are significantly lower than predicted by historical flow record.

<sup>18</sup> Specific analyses each require some minimum volume of sample. Therefore, the minimum required sample volume depends on the location-specific analyte suite.

<sup>19</sup> The expected discharge volume is the historic average volume. Generally, all available flow record after October 1, 1992, is used (data prior to October 1, 1992, is considered less reliable). The actual period of record depends on monitoring location. Due to the significant reduction in runoff following Site closure, professional judgment is used where appropriate.

<sup>20</sup> The Site currently employs 15- and 22-L composite sample bottles (carboys).

- [4] The expected discharge volume is then divided by the targeted number of grab samples to obtain a discharge volume per grab sample. This is the flow pace for the composite sample.

Continuing with the GS10 example, collecting 60 grab samples for a stream discharge of 1.37 MG results in a flow pace of 22,833 gallons per grab sample.

### **8.1.2 Surface Water Field Data Collection**

#### ***Manual Field Data Collection***

The following sections describe data and information collected by field personnel, as opposed to automated equipment.

##### ***Field Parameters***

QC objectives for the collection of field parameters and representative samples of surface water are established to ensure that data are of sufficient quality to support the decisions identified in the following sections. The QC objectives for field data collection are the following:

- Sampled water is representative of surface water;
- Sampling techniques do not introduce contaminants into samples;
- Sampling techniques are generally standardized for improved reproducibility and comparability of results; and
- Water levels are measured precisely enough to detect minor fluctuations (approximately  $\pm 0.005$  foot) in stage.

The SAP and this RFSOG are followed to ensure that quality samples are collected for use in environmental decision making.

#### ***Automated Field Data Collection***

The types of data that the station instrumentation automatically collects include the following depending on the location-specific monitoring objective:

- Continuous record of stream stage (later converted to discharge) on 5-minute intervals.<sup>21</sup> These data are continuously logged by the flow meter.
- Surface water sample record, indicating date and time of the collection of individual grab samples that are composited in the sample bottles. These data are continuously logged by both the flow meter and the automated sampler.
- Continuous record of precipitation at 5-minute intervals.<sup>22</sup>

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<sup>21</sup> Flow data are subsequently calculated using the 5-minute data summarized on 15-minute intervals; the higher resolution 5-minute data are collected to allow for more detailed evaluation if needed.

<sup>22</sup> Precipitation gages are positioned across the Site to collect representative Sitewide variations and allow for areal precipitation calculations.

### ***Flow and Precipitation Data Collection***

As stated previously (see Section 7.1), routine inspection and maintenance of the monitoring stations are required to detect leaks or damage to the flow-control structures, troubleshoot problems with the instrumentation, and provide calibration notes for subsequent computation of the discharge records for each station. Flow meter levels are adjusted to match staff gages on an as-needed basis. Flow measurement equipment may be performance-checked, repaired, or replaced as needed based on data trends and professional judgment. The flow meters log stream stage continuously, storing data points at 5-minute intervals. Particular care is needed during winter freezing conditions to prevent damage to the flow meters. This may involve temporary suspension of flow data collection until more favorable weather conditions resume, providing substantially ice-free conditions such that flow meters and flumes/weirs can be operated effectively.

At select locations, continuous records of precipitation are collected at 5-minute intervals. Precipitation gages are positioned across the Site to collect representative Sitewide variations and allow for areal precipitation calculations. Precipitation gages are performance-checked monthly to manufacturer's recommendations. Precipitation equipment may be performance-checked, repaired, or replaced as needed based on data trends and professional judgment.

At least once a month, the water level and precipitation data are downloaded from the flow meters to a laptop PC. These data are then transferred to Site servers for compilation and evaluation (see Section 8.2.1). All data are backed up to multiple electronic media to avoid accidental data loss. All flow data are also uploaded to the Site's SEEPro database for archival purposes. Many of the collected data are also logged via telemetry as a secondary (redundant) data collection platform. In addition, flow meters are equipped with real-time paper strip chart recorders that record water levels, precipitation, and sample event marks.

### ***Applicable Software***

The ISCO<sup>®</sup> monitoring equipment operates on proprietary Flowlink software. This software operates on a laptop computer, which is used to program the instrumentation and download field data. This software is also operated on office workstations for subsequent data evaluation.

The Geomation<sup>®</sup> telemetry operates with the Model 3106 OPC Data Access Server with a RTU configurator. This software is used to program the instrumentation and interface with data logging and evaluation software. The Geomation Model 3106 is OPC-compliant, providing an industry-standard interface for the entire OutDAQ product line. OPC is a set of industry standards providing interoperability between field equipment, such as RTUs, with automation software for logging, archiving, and displaying data. The 3106 OPC Data Access Server provides a Modbus serial interface to 3300/3310 RTU networks, as well as a uniform data access interface to leading client software packages for SCADA/HMI, data acquisition, trending, and archiving. For the OPC Client, the Site currently uses the OPC Systems.NET software package for tagging and logging of data. The Site has developed several Visual Basic applications and ODBC-linked Excel spreadsheets for routine data evaluation and reporting.

### ***Applicable Instructions and Resources***

Data collection procedures are further outlined in manufacturer instruction manuals. The applicable manufacturer manuals and other resources are listed in Section 7.1.

### **8.1.3 Groundwater Monitoring Considerations**

#### ***Scheduling***

Wells that are sampled semiannually will be sampled during the spring and winter quarters (second and fourth calendar quarters, respectively) because these generally represent high- and low-water conditions at the Site. Data from these wells will therefore reflect a broad range of conditions. Wells scheduled for annual sampling will be sampled during the spring quarter, as will wells scheduled for biennial sampling.

To the extent that it is feasible, all groundwater samples (and corresponding surface water grabs, where appropriate) collected in support of a given plume or source area should be collected together, over a short period of time, so that data from the individual locations correspond closely in time with each other. This allows a more accurate “snapshot” of groundwater conditions (and, in some cases, related surface water conditions) in each area, and also enhances the efficiency of the monitoring program. If feasible, wells that are consistently low producers should be sampled in the early part of a sampling period to allow more time for the water level to equilibrate before the next-scheduled water level measurement. Table 6–1 lists the required sampling frequency, and Table 8–1 summarizes groundwater sample collection schedule considerations via suggested well groupings.

Sampling per the suggested groupings is not required but may enhance the usability of the data. Some locations fall outside the areas of interest and may be monitored when convenient. This applies to the Boundary wells, as shown in Table 8–1, but also applies to other wells that, because of a correlation between locations and monitoring objectives, are listed within groups (such as well 30002 in the PLF/PU&D Yard group, well 22996 in the 903 Pad/Ryan’s Pit Plume group, and well 45608 in the Oil Burn Pit #2/B991/Mound group; the latter two wells could alternatively be monitored together to support the last of these groups). Finally, note that only a subset of the wells in each group may need to be monitored in any given quarter.

Table 8–1. Scheduling Monitoring Location Groups for Optimal Data Usability

North Supergroup	North Supergroup (continued)	East Supergroup (continued)	
Oil Burn Pit #1 / B371 Group	PLF / PU&D Group	East Trenches Plume Group	
33502	70193	3687	
33604	70393	05691	
33703	70693	03991	
33905	73005	04091	
37405	73105	95099	
37505	73205	95199	
37705	4087	95299	
North-Central IA Group	B206989	23296	
P114689	30900	ET INFLUENT	
55905	30002	ET EFFLUENT	
56305		POM2 (grab)	
21505		00997	
P115589			
70705			
B771 / IHSS 118.1 Group			East Supergroup
20205	Oil Burn Pit #2 / B991 / Mound Group		
20505	45608		
20705	91105		South Supergroup
42505	91203		B444 Group
18199	91305		40005
20902	99305	40205	
52505	99405	40305	
SW018 (grab)	00897	P419689	
SEP Group	15699	P416889	
P210189	MOUND R1-0	11502	
79102	MOUND R2-E	OLF Group	
79202	GS10 (grab)	P416589	
P208989	903 Pad / Ryan's Pit Plume Group	80005	
79302	22996	80105	
79402	00191	80205	
79502	07391	11104	
79605	90402	B881 / 881 Hillside Group	
00203	50299	88104	
22205	00491	88205	
P210089	90804	00797	
70099	90299	891WEL	
B210489	90399	89104	
51605	10304		
10594	00193		
SPPMM01			Wells that aren't in any group
SPP DIS GAL			
SP IN			10394
GS13 (grab)		41691	

## Sampling

Guidelines for the collection of groundwater samples are provided in the SAP. Basic requirements include:

- Groundwater samples will generally be collected using peristaltic pumps, bladder pumps, or freshly decontaminated, reusable bailers. Bailed wells will be purged and sampled gently to reduce the agitation caused by use of a bailer.
- Groundwater samples to be analyzed for total uranium, plutonium, and americium, or metals (which must include uranium) will be field-filtered; those to be analyzed for VOCs, semivolatile organic compounds (SVOCs), or nitrate will be unfiltered. Where surface water samples are collected in support of groundwater objectives, the sampling requirements imposed by surface water methodologies will be allowable unless the groundwater lead determines this to be inappropriate, in which case the sampling methods will be changed or additional samples will be collected. For example, at GS13, analytical data for isotopic uranium in unfiltered samples are reported, and are converted to total uranium mass, with any necessary notations made regarding this conversion and the unfiltered condition of the samples. If this was deemed inappropriate, either the sampling method would be changed or grab samples would be collected and filtered for the analysis of total uranium.
- Field parameters that will be measured include temperature, pH, specific conductance, turbidity, and total alkalinity. These will be measured during the purging process and will be used to confirm the completion of purging. Other parameters may be requested on occasion.
- If limited groundwater sample volumes prevent collection of the full suite assigned to a given well, samples for analysis generally will be collected in the order defined below. (Note that samples for many of the listed analytes are only collected at a very few locations. Refer to Table 2 of Attachment 2 to RFLMA for well-specific analytical suites.)
  - VOCs;
  - SVOCs;
  - Nitrate;
  - Metals;
  - Total uranium; and
  - Plutonium-239,240 and americium-241.

The order in which analytical samples are to be collected may be altered to fit statistical needs or for specific wells/areas. Field-filtered samples for the analysis of dissolved plutonium and americium are included in the analytical suite for several wells located downgradient of former Buildings 371 and 771. These data will be used to confirm that closure of those facilities has not impacted downgradient groundwater with these radionuclides. For additional discussion of this topic, refer to the *Actinide Migration Evaluation Pathway Analysis Report* (K-H 2002c) or the *Interim Measures/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site* (K-H 2005).



### 8.1.4 Groundwater Field Data Collection

Field parameters such as pH, temperature, specific conductance, alkalinity, and turbidity will be measured during groundwater sample collection activities. Other parameters may also be measured if desired, such as dissolved oxygen, Eh or oxidation-reduction potential, and others. In all cases, instructions supplied by the instrument manufacturer will be followed to generate quality data. Similarly, these instruments will be maintained as instructed by the manufacturer. Maintenance may include such activities as disassembly and cleaning, adjustment, calibration, and/or return to the manufacturer or a third party for maintenance. When an instrument is deemed faulty, it will be taken out of service immediately, and any suspect data it may have generated will be flagged as such. The instrument will be repaired or replaced as soon as possible if necessary for the continued efficient operation of the program. If not repaired or replaced, it will be disposed of so that it is not inadvertently used for data collection at a later time. Refer to the SAP for additional information.

## 8.2 Data Evaluation

Data evaluation is performed to meet requirements of RFLMA and to support implementing BMPs for overall Site surveillance and maintenance activities. Section 9.6 provides a discussion of source evaluations that may be performed due to a RFLMA reportable condition.

### 8.2.1 Surface Water Hydrologic Data

Flow and precipitation data are compiled and evaluated using industry standard criteria, manufacturer recommendations, and the resources discussed in Sections 7.1.3 and 8.1.2. Data are routinely considered and evaluated in the following ways:

- Values are checked using the radio telemetry equipment for project management decision support.
- A detailed workup of 15-minute interval data is generated and archived.
- A detailed workup and evaluation of daily averages is compiled and archived.

Additional evaluation may be performed for a variety of reasons including source evaluations, special requests, project-specific monitoring evaluations, and hydrologic studies.

#### *Discharge Data Compilation and Computation*

Data obtained at a continuous surface water gaging station on a stream or conveyance, such as an irrigation ditch, consist of a continuous record of stage,<sup>23</sup> individual measurements of discharge throughout a range of stages, and notations regarding factors that might affect the relation of stage to discharge. These data, together with supplemental information such as climatological records (e.g., temperature and precipitation), are used to compute daily mean discharges.

Continuous records of stage are obtained with electronic recorders that store stage values at select time intervals or secondarily with radio-telemetry data-collection platforms that transmit near-real-time data at select time intervals to a central database for subsequent processing. Direct

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<sup>23</sup> Stage is the water level (in units such as feet or meters) in a conveyance structure.

field measurements of discharge are made with current meters, using methods adapted by the U.S. Geological Survey (USGS), or with flumes or weirs that are calibrated to provide a relation of observed stage to discharge. These methods are described by Carter and Davidian (1968) and Rantz (1982a, 1982b).

For standard flow-measurement devices (e.g., flumes and weirs), rating tables indicating the discharge for any stage within the range of the device are prepared based on the geometry of the device. If it is necessary to define extremes of discharge outside the range of the device, the curves can be extended using (1) logarithmic plotting, (2) velocity-area studies, (3) the results of indirect measurements of peak discharge, such as slope-area or contracted-opening measurements, and computation of flow over dams or weirs, or (4) step-back-water techniques.

Daily mean discharges are computed by averaging the individual discharge measurements calculated from the stage-discharge curves or tables. If the stage-discharge relation is subject to change because of frequent or continual change in the physical features that form the control, the daily mean discharge is determined by the shifting-control method, in which correction factors based on the individual discharge measurements and notes by personnel making the measurements are applied to the gage heights before the discharges are determined from the curves or tables. This shifting-control method also is used if the stage-discharge relation is changed temporarily because of aquatic vegetation growth or debris on the control. For some gaging stations, formation of ice in the winter can obscure the stage-discharge relations so that daily mean discharges need to be estimated from other information, such as temperature and precipitation records, notes of observations, and records for other gaging stations in the same or nearby basins for comparable periods.

For most gaging stations, there may be periods when no gage-height record is obtained or the recorded gage height is faulty so that it cannot be used to compute daily mean discharge or contents. This record loss occurs when recording instruments malfunction or otherwise fail to operate properly, intakes are plugged, the stilling well is frozen, or various other reasons. For such periods, the discharges are estimated from the recorded range in stage, previous or following record, discharge measurements, climatological records, and comparison with other gaging-station records from the same or nearby basins.

### **8.2.2 Groundwater Data**

Routine chemical analysis of groundwater identifies the contaminants present and their concentrations with respect to applicable water quality standards. These data are compared against predetermined and/or well-specific concentrations to identify whether reported concentrations in groundwater are indicative of worsening conditions.

Depending on the well classification and analyte, concentrations are compared in accordance with one or more of the following criteria:

- Individual analytical results are compared with surface water standards identified in Table 1 of Attachment 2 to RFLMA;
- Statistically derived 85th percentile concentrations are compared with the same surface water standards;

- Specific statistical methods are used to determine concentration trends; and/or
- Concentrations in downgradient wells are compared against those in upgradient wells.

In addition to these criteria, a “threshold concentration” is used for comparison of uranium results. Data from wells associated with monitoring for RCRA purposes are evaluated differently, as discussed in their respective sections.

These concepts are discussed below. Well classifications, which determine which of the criteria above apply, are listed in Table 6–1.

### ***Data Usage***

Of the analytical data received from laboratories, 100 percent will be validated and verified. In addition, analytical results that appear anomalous or are of special interest may receive more detailed validation on request. The groundwater lead will make the final determination of whether this additional validation is warranted and, if so, will work with the analytical data lead to have this done. Data qualified as “rejected” during the validation process (validation qualifier containing an “R”) will not be used in any of the data evaluations.

Analytical data for any analyte in which the result is qualified with a “U” (not detected at the reported detection limit), either by the laboratory or via data validation, will be considered “nondetect.”

Groundwater data evaluations will be based on water sampling performed since January 1, 2000. This period of record allows sufficient historical data for evaluation of recent groundwater quality trends without the bias introduced by including much older data collected when the Site was far from closure. Exceptions to this date may be made if necessary and if supported by professional judgment. In particular, all uranium data generated using high-resolution inductively coupled plasma/mass spectrometry (HR ICP/MS) or thermal ionization mass spectrometry (TIMS) analytical methods have been included, regardless of the date of analysis. These data were collected from select locations for characterization purposes beginning in 1999.

Analytical data for primary (“FIELD SAMPLE” or “F” in SEEPro) samples will be used for evaluating groundwater quality trends and 85th percentile calculations. Samples collected to meet QA/QC requirements (e.g., field duplicates, trip blanks, and equipment blanks) may be used in performing data quality assessments (DQAs), but are not used for groundwater quality evaluation.

Numerous wells were replaced as a result of Site closure activities. The appropriateness of pooling data from the “original” well with those from the “replacement” well (or wells, if the well has been replaced more than once) will be determined on a case-by-case basis, using professional judgment, and will typically depend on the objective of the data evaluation (e.g., simple time-series plots as opposed to statistical trending). Three examples illustrate why inflexible data-pooling requirements would be inappropriate:

1. Some wells were replaced because the original well was inadvertently damaged or had to be removed to accommodate demolition activities. Construction, design, and location of the replacement well may be essentially identical to that of the original well. In cases

such as this, analytical data from the original and replacement wells should probably be pooled.

2. In some cases, original wells were installed within a contaminant source area that was subsequently remediated via source removal, thereby also removing the original well. A replacement well may then have been installed at the downgradient edge of the excavation boundary after source removal activities were completed. Pooling of analytical data from the original and replacement wells in this case would typically not be appropriate, at least for such purposes as trend calculations.
3. If the geochemical conditions indicated by the analytical data from the replacement well are markedly inconsistent with those from the original well (as may be evident in time-series plots, for example), it may be appropriate to discontinue data pooling. Discontinuous trend plot behavior would be evident in the second example above, but in some instances the reason for the inconsistencies may not be known (e.g., there was no source removal).

Table 8–2 provides a crosswalk of original and replacement well identifications.

Table 8–2. Crosswalk of Original and Replacement Well Identifications

Original Well	Replacement Well	General Location Description
00200	70705	East side of B707
00297	00203	South side of SEP
1386	51605	North Walnut Creek west of Pond A-1
1986	52505	West of B771/774 in unnamed drainage
20298	20205	North of B771/774
20598	20505	North of B771/774
20798	20705	North of B771/774
20998	20902	West of B771 in unnamed drainage
21098	21002	West of B771 in unnamed drainage
21398	21305	West of B776 in unnamed drainage
21598	21505	West of B776 in unnamed drainage
21698	21605	West of B559, B776 in unnamed drainage
2187	91305	South Walnut Creek southeast of B991
22298	22205	North of SEP
33603	33604	South of B371/374 near Oil Burn Pit #1 source area
33904	33905	Southeast of B371/374
37101	37105	West of B371/374
37401, 37402	37405	North of B371/374
37501	37505	North of B371/374
37701	37705	East of B371/374
39691	39605	West of B881
40099	40005	West of B444
40299	40205	South of B444
40399	40305	East of B444
45605	45608	South of B991
5187	88205	South of B881
55901	55905	North of B559
56301	56305	West of B559
88101	88104	South of B881
891COLWEL	891WEL <sup>a</sup>	OU 1 Plume source area
90803	90804	903 Pad/Ryan's Pit Plume
91103, 91104	91105	Oil Burn Pit #2 source area
99301	99305	East of B991
99401	99405	East of B991
P207989	79605	East of SEP

Notes: <sup>a</sup>891COLWEL was a large-diameter collection well equipped with a dedicated industrial pump. The pump was removed and a 2-inch polyvinyl chloride (PVC) well was installed within the larger-diameter casing of the collection well. This PVC well is named 891WEL. A new name was required because of the changes in downhole conditions and sampling methods.

Source: 2006 IMP (DOE 2006f) except information related to original well 45605, which was replaced in 2008 due to a slump that developed and damaged the original well.

### Comparing Data with Standards

RFLMA requires that analyte concentrations in groundwater be compared against the greater of the standard, PQL, or TM listed in Table 1 of Attachment 2 to RFLMA, or to the appropriate uranium threshold also defined in that attachment and discussed further below. Because Site groundwater quality must be protective of surface water quality, the groundwater quality data for

constituents other than uranium will be compared with surface water standards, PQLs, and TMs as described below. The surface water standards, PQLs, and TMs are hereafter referred to collectively as “surface water standards.” Analyte concentrations in groundwater may also be compared against concentrations reported at other wells.

Concentrations of a particular analyte in a particular monitoring well are referred to as an “analyte-well” combination. Except in specific instances concerning results from AOC and Boundary wells, as provided on the Figure 7 flowchart in RFLMA (Attachment A2), concentrations of an analyte-well will not be considered greater than the applicable surface water standard until the 85th percentile of the data for that analyte-well is above the standard. This will prevent a single data point, with its associated uncertainty in sampling and analysis, from causing unnecessary follow-up actions.

The 85th percentile of the analyte-well data is estimated by the nonparametric method described by the Colorado Water Quality Control Commission (CWQCC) guidance (CWQCC 2004, p. 4). This procedure is as follows:

1. Nondetect<sup>24</sup> concentrations are replaced by zeros for the procedure.
2. Potential data outliers are retained in the working dataset.
3. The concentration data are grouped by analyte and then by well.
4. Within each group of “n” data points, the concentrations are sorted in ascending order from smallest to largest concentration.
5. Each concentration is assigned an integer rank or “order statistic.” The first nondetect (or smallest detect if there are no nondetects) is assigned rank 1. The largest concentration is assigned rank n.
6. The 85th percentile is estimated by the concentration whose rank is  $0.85(n+1)$ , if the rank is an integer.
7. If the above percentile rank is not an integer, the rank is rounded to the closest integer rank. The 85th percentile is then taken as the concentration of the closest integer rank.
8. In cases where the direction of rounding is ambiguous, interpolation between the ranks is suggested. This issue is not addressed by CWQCC guidance (2004).
9. Percentiles are not estimated until there are a minimum of eight regularly scheduled concentration measurements (i.e., eight successful sampling events from the routine semiannual or other applicable schedule) for an analyte-well. This is consistent with the minimum dataset for trending, discussed below. CWQCC does not address the minimum sample size for estimating percentiles.

The CWQCC procedure (2004) is nearly identical to that given by the widely cited statistical text, Snedecor and Cochran (1967, p. 125), for estimating percentiles of any continuous frequency distribution. The difference is that Snedecor and Cochran (1967) call for linear interpolation of the percentile when the order statistic is not a whole number. CWQCC guidance (2004) calls for “rounding down”; water quality comparisons at the Site employ ordinary rounding to the nearest integer, rather than truncation to the next lower integer.

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<sup>24</sup> Any analyte not detected at the reported detection limit is considered nondetect.

## ***Trend Analysis***

Groundwater quality data will be compiled into a database and evaluated for trend as follows:

1. Trends are not estimated until there are a minimum of eight regularly scheduled concentration measurements (i.e., eight successful sampling events from the RFLMA-required semiannual or other applicable schedule) for an analyte-well. Trends based on fewer routinely collected data will not drive compliance decisions. For example, 2 years of quarterly results at a location where the RFLMA-required monitoring frequency is semiannual may provide eight results, but actually only four routine results; another 2 years of semiannual monitoring data would be necessary to collect the minimum of eight routine results.
  - Trend analysis requires a minimum of four data points per sampled season.
2. Potential data outliers are retained in the working dataset.
3. Nondetect concentrations are replaced by zeros so that nondetects are lower than detects at the reporting limit. This also treats all nondetects as ties when multiple reporting limits are present in the data. However, some statistical calculations cannot proceed if zeroes are in the dataset; in such cases, nondetects are typically replaced with a near-zero value such as 0.001. (The RFLMA standard will need to be considered when replacing nondetects, to ensure the replacement value does not cause an unacceptable bias in the statistical results.)
  - It is not necessary to test for trend if all of the concentrations for an analyte-well are nondetect. There is no evidence of trend in this case.
4. Data for each analyte-well is tested for trend by applying the nonparametric Seasonal-Kendall (S-K) test and the associated S-K slope estimator (K-H 2004f). The S-K test is described by Hirsch et al. (1982) and Gilbert (1987, Chapter 17). If the well is sampled on an annual or biennial schedule (once per year or once every other year, respectively), the Mann-Kendall (M-K) test may be used if desired, since seasonality will not be a factor.
5. The S-K (or M-K, if applicable) test is applied at the 95 percent level of confidence for a one-tailed test (i.e., false positive error level  $\alpha = 0.05$ ).
  - It is recommended that the S-K (or M-K) method be calculated by commercially available statistical software.

The null hypothesis ( $H_0$ ) of the S-K test is that there is no trend. The S-K test statistic is identified as “Z.” The one-tailed S-K test for an uptrend at the  $\alpha = 0.05$  level finds sufficient evidence to reject  $H_0$  if test statistic Z is positive and greater than table value  $Z_{0.95}$ . Table values for the test may be found in Gilbert (1987, Table A1). Similarly, statistically significant evidence of a downtrend is found when Z is negative and the absolute value of Z is greater than  $Z_{1-\alpha}$ . Further considerations on trend testing of Site groundwater data are found in K-H (2004f).

## ***Comparison with “Threshold” Concentration of Uranium***

Rocky Flats is located in an area with high background levels of uranium in soil and groundwater. These background levels are naturally occurring. Therefore, because the

corresponding uranium surface water standard is relatively low, a separate rule has been created for uranium concentration comparisons in groundwater.

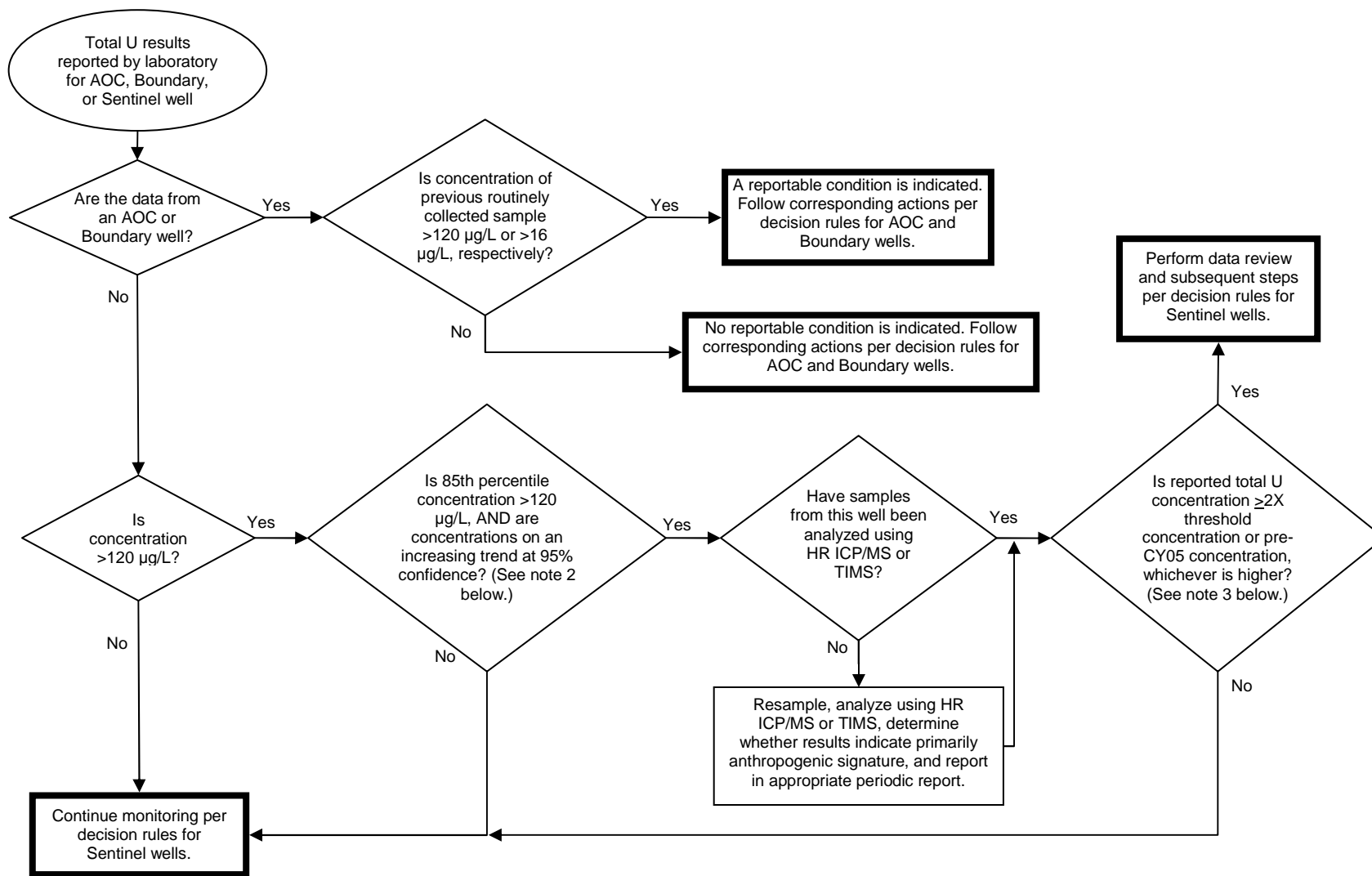
Concentrations of total uranium from a given AOC or Boundary well will be compared directly with the corresponding uranium threshold (120 and 16 micrograms per liter [µg/L], respectively). Concentrations of total uranium from a given Sentinel well will be assessed using statistical trending, calculation of the 85th percentile concentration, and comparison of the 85th percentile concentration with the 120 µg/L uranium threshold. In addition, high-resolution isotopic data collected during uranium characterization efforts may apply at Sentinel wells, as shown on Figure 8–2.

These threshold values were selected in consultations with CDPHE and EPA. The 16 µg/L concentration is based on a conversion of the 11 pCi/L Site-specific surface water standard for Woman Creek. The 120 µg/L concentration is rounded from the grand mean of samples collected at RFETS and analyzed using HR ICP/MS or TIMS through groundwater characterization efforts of 1999–2003. As part of these efforts, over 50 wells in areas of contamination as well as the former BZ were sampled for the analysis of uranium using HR ICP/MS or TIMS. Results of HR ICP/MS and/or TIMS analysis can be assessed to determine whether the isotopic signature is indicative of natural uranium (i.e., naturally present in the water, soils, and rocks) or shows anthropogenic (manmade) influence. Due to the elevated natural uranium concentrations at Rocky Flats, this determination is important in designing a response to elevated uranium concentrations.

If the total uranium concentration at a given AOC or Boundary well exceeds the corresponding uranium threshold, or the 85th percentile total uranium concentration at a given Sentinel well exceeds the threshold concentration, additional inspection of the data will be required. Figure 8–2 guides this process.

The total reported pCi value may be converted to micrograms (µg) using the conversion factors in Table 8–3. To convert total natural uranium reported in mass units to activity units, the factor is 0.68596 pCi/µg (derived from Friedlander 1981).





Notes: See RFLMA Attachment 2 Figure 1 and Tables 1 and 2 for locations, standards, and sampling criteria (Attachment A2).

1. For Boundary wells, the 16 µg/L concentration is based on the 11 pCi/L surface water standard converted to mass units, assuming a natural isotopic signature.
2. For AOC and Sentinel wells, the 120 µg/L concentration is based on a grand mean of HR ICP/MS and TIMS data collected Site-wide from the late 1990s through mid-2000s.
3. "Highest pre-CY05" concentration is the maximum of either the reported total uranium (i.e., in mass units) or as converted from activity units to mass units.

Figure 8-2. Uranium Threshold Flowchart

Table 8–3. Activity to Mass Conversion Factors for Uranium Isotopes

Analyte	Mass/Activity (g/Ci)
U-233,234	1.6 E+02
U-235	4.63 E+05
U-238	2.98 E+06

Notes: These conversion factors for U-233,234, U-235, and U-238 were taken from 40 CFR, Chapter I, Part 302.4, Appendix B, October 7, 2000.

At AOC and Boundary wells, confirmatory results will be required; these will be obtained during the next regularly scheduled sampling event. If the second sample confirms the initial concentration (i.e., the second result also exceeds the uranium threshold for AOC or Boundary wells, as applicable), this second result suggests a reportable condition exists. The second result will be thoroughly validated and, if confirmed, the steps defined on the Figure 7 flowchart in RFLMA (Attachment A2) for a reportable condition will be taken.

At Sentinel wells, the statistical trend of the uranium data will be calculated to determine whether uranium is increasing at the 95 percent confidence level. If this condition is true at a given Sentinel well, the next consideration will be whether samples from the well have previously been analyzed using HR ICP/MS or TIMS; if not, this will be one component of the follow-up. If samples from this Sentinel well have been analyzed using either of these methods, the just-reported total uranium result will be compared against two times the highest pre-CY 2005 concentration and two times the associated uranium threshold. Concentrations exceeding these values will signal off-normal conditions that warrant careful inspection.

The highest pre-CY 2005 concentration data may be reported as total uranium (i.e., in units of mass) or as isotopic activities that are then converted to mass and summed for an equivalent total uranium concentration. Data to be used for this comparison include isotopic and total uranium data from samples collected January 1, 2000, through December 31, 2004, and all HR ICP/MS and TIMS data reported by Los Alamos National Laboratory (LANL) prior to December 31, 2004. Table 8–4 lists the highest pre-CY 2005 uranium concentrations for AOC, Boundary, and Sentinel wells that are represented by pre-CY 2005 data.

When HR ICP/MS or TIMS data are required, samples will be collected and delivered to the appropriate laboratory; to date, all such data have been generated by LANL. Upon receipt of the corresponding results, the isotopic data will be reviewed to determine whether they indicate a predominantly natural or anthropogenic signature. Next, one of the following two options will be taken:

- If a natural signature is indicated, the regulatory agencies will be informed and normal sampling and analysis will resume.
- If a definitive anthropogenic signature is indicated, the action specified for that well classification will be performed.

Table 8–4. Highest Pre-CY05 Uranium Results for AOC, Boundary, and Sentinel Wells

Well/Replacement Well <sup>a</sup>	IMP Classification	Maximum Uranium Concentration (µg/L) <sup>b</sup>
11104	AOC	61.1
10594	AOC	155.0
10304	AOC	11.7
00997	AOC	21.2
00193	AOC	114.1
B206989	AOC	144.8
4087	AOC	63.6
41691	Boundary	8.2
10394	Boundary	10.2
P210089	Sentinel	12.8
99401/99405	Sentinel	831.5
99301/99305	Sentinel	544.0
91203	Sentinel	3.7
90399	Sentinel	21.1
90299	Sentinel	118.0
88101/88105	Sentinel	629.1
70299	Sentinel	22.2
40399/40305	Sentinel	0.6
37701/37705	Sentinel	18.7
37501/37505	Sentinel	2.6
37401/37402/37405	Sentinel	73.6
23296	Sentinel	53.8
2187/91305	Sentinel	36.0
20798/20705	Sentinel	1.0
20598/20505	Sentinel	9.6
20298/20205	Sentinel	40.2
1986/52505	Sentinel	10.6
15699	Sentinel	44.6
1386/51606	Sentinel	35.6
11502	Sentinel	3.1
04091	Sentinel	4.7
00797	Sentinel	27.4

Notes: <sup>a</sup>The maximum value for a given location is used regardless of whether it is from a replacement well or its predecessor.

<sup>b</sup>The value shown represents the maximum of three possible values: data reported as total uranium in µg/L; data reported as isotopic uranium in parts per billion and then summed; or data reported as isotopic uranium in pCi/L and summed, and then converted to µg/L using the conversion factor for natural uranium. In each case, the result is rounded to the nearest 0.1 µg/L.

Source: Modified after the 2006 IMP (DOE 2006f), with appropriate RFLMA-required changes in well classifications.

Decisions that may be required in response to detection of elevated concentrations of total uranium will generally be made following the data evaluation flowchart shown on Figure 8–2, as required by the flowchart for the corresponding well classification.

### 8.2.3 Surface Water Data

Routine chemical analysis of surface water identifies the contaminants present and their concentrations with respect to applicable water quality standards. These data are compared against standards to identify whether measured water quality is acceptable.

Depending on the monitoring objective and analyte, concentrations are compared using one or more of the following criteria:

- Compliance parameters<sup>25</sup> are compared with surface water standards identified in Table 1 of Attachment 2 to RFLMA according to the applicable data evaluation flowcharts in RFLMA (Attachment A2);
- Individual results are compared with surface water standards identified in Table 1 of Attachment 2 to RFLMA according to the applicable data evaluation flowcharts in RFLMA (Attachment A2); and/or
- Results from downstream locations are compared against those in upstream locations according to the applicable data evaluation flowcharts in RFLMA (Attachment A2).

These concepts are discussed below. Monitoring objectives, which determine which of the criteria above apply, are summarized in Table 6–1; details can be found in the specific objective sections above.

#### *Data Usage*

Of the analytical data received from laboratories, 100 percent will be validated and verified. In addition, analytical results that appear anomalous or are of special interest may receive more detailed validation on request. The surface water lead will make the final determination of whether additional validation is warranted. Data qualified as “rejected” during the validation process (validation qualifier containing an “R”) will not be used in any of the data evaluations.

Interpretation of analytical data for any analyte in which the result is qualified with a “U” (not detected at the reported detection limit) will be considered nondetect. When a nondetect result is returned from the laboratory, then one-half the detection limit (for metals) or the detection limit (for VOCs/SVOCs) is used for calculation purposes. All radionuclide results will be used, regardless of a “U” qualifier.

When a negative radionuclide result (e.g.,  $-0.002$  pCi/L) is returned from the laboratory due to blank correction, a value of 0.0 pCi/L is used for calculation purposes.

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<sup>25</sup> Applicable compliance parameters are detailed in the specific monitoring objective sections (e.g., 12-month rolling averages, 30-day averages, and so forth). Methods for calculating these compliance parameters are given below.

Data pairs (e.g., a real result and its corresponding duplicate) for radionuclides will be screened using the duplicate error ratio (DER) to determine the representativeness of the values; all other analyte pairs will be screened using the relative percent difference (RPD).<sup>26</sup> Details regarding the handling of data pairs is given below for POC and POE data evaluation.

Analytical data for primary (“FIELD SAMPLE” in SEEPro) and duplicate<sup>27</sup> samples will be used for evaluating surface water data. Samples collected to meet QA/QC requirements (e.g., field duplicates, trip blanks, and equipment blanks) may be used in performing DQAs.

### *Comparing Data with Standards*

RFLMA requires that analyte concentrations in surface water be compared against the greater of the standard, PQL, or TM listed in Table 1 of Attachment 2 to RFLMA. The surface water standards, PQLs, and TMs are hereafter referred to collectively as “surface water standards.”

### *POC and POE 30-Day Averages*

Evaluation of analytical data using 30-day volume-weighted moving averages is currently performed for the POE and POC monitoring objectives. The method is as follows:

- Calculations are performed using daily time steps. The 30-day average for a particular day is calculated using a “window” of time that includes the previous 30 days that had both flow and analytical measurements. Therefore, for a location with continuous flow and complete analytical results, 365 (366 in a leap year) 30-day average values are calculated annually. For a location that flows intermittently, the 30-day window includes the previous 30 days with greater than zero flow. Therefore, the 30-day average at an intermittently flowing location will include more than 30 *calendar* days.
- When no analytical result or measured flow value is available for a particular day, then no 30-day average is calculated for that day. No analytical result may be available either due to NSQ for analysis (Section 8.1.1) or a failed laboratory analysis. Flow measurement may be missing due to equipment failures or adverse weather conditions (e.g., winter freezing).
- When a negative radionuclide result (e.g.,  $-0.002$  pCi/L) is returned from the laboratory due to blank correction, then a value of  $0.0$  pCi/L is used for calculation purposes. When a nondetect result is returned from the laboratory for metals and water quality parameter analyses, then one-half the detection limit is used for calculation purposes.
- When a sample has a corresponding duplicate or reanalysis (“re-run”), **AND** *neither* result is greater than the applicable water quality standard, **THEN** the value used in calculations is the arithmetic average of the values.
- When a sample has a corresponding duplicate or reanalysis (“re-run”), **AND** *either* result is greater than the applicable water quality standard, **THEN** an evaluation of the data pair is

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<sup>26</sup> Significant differences in values for a data pair are an indication of potential problems with sample preparation and/or analysis. Under these circumstances, an applicable value to be used for comparison cannot be determined with sufficient confidence to make compliance decisions. As such, an evaluation is required to assess the representativeness of the sample and its usability for compliance decisions.

<sup>27</sup> When both the “real” and “duplicate” results are from the same sampling event, results will be arithmetically averaged, subject to DER and RPD calculation. Similarly, results from a valid reanalysis will also be included.

performed to determine the representativeness of the sample results.<sup>28</sup> The method for determining representativeness is given below.

#### ***Determining Representativeness for Metals and Water Quality Parameters***

1. The RPD for the data pair is calculated:

$$RPD(\%) = \frac{|R_1 - R_2|}{(R_1 + R_2)/2} * 100$$

where (Equation 8-1)

$R_1$  = value of initial result

$R_2$  = value of duplicate result

- 2a. **IF** the RPD is greater than or equal to 100 percent ([higher result]  $\geq$  3x [lower result]), **THEN** the results will be determined to be nonrepresentative. The results will not be used for the calculation of 30-day averages, and no 30-day average values will be computed for the days during which the sample was collected.
- 2b. **IF** the RPD is less than 100 percent ([higher result]  $<$  3x [lower result]), **THEN** the results will be determined to be sufficiently representative. The arithmetic average of the results will be used for the calculation of 30-day average values.

#### ***Determining Representativeness for Radionuclides***

1. The DER for the data pair is calculated:

$$DER = \frac{|R_1 - R_2|}{\sqrt{(2\sigma_{R1})^2 + (2\sigma_{R2})^2}}$$

where

$R_1$  = value of initial result

$R_2$  = value of duplicate result

$2\sigma_{R1}$  = 2 sigma error of initial result

$2\sigma_{R2}$  = 2 sigma error of duplicate result

(Equation 8-2)

- 2a. **IF** the DER is greater than or equal to 1.5, **THEN** the results will be determined to be nonrepresentative. The results will not be used for the calculation of 30-day averages, and no 30-day average values will be computed for the days during which the sample was collected.

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<sup>28</sup> Significant differences in values for a data pair are an indication of potential problems with sample preparation and/or analysis. Under these circumstances, an applicable value to be used for the calculation of 30-day averages cannot be determined with sufficient confidence to make compliance decisions. As such, an evaluation is required to assess the representativeness of the sample and its usability for compliance decisions.

- 2b. **IF** the DER is less than 1.5, **THEN** the results will be determined to be sufficiently representative. The arithmetic average of the results will be used for the calculation of 30-day average values.
- Each calendar day is assigned the activity or concentration (analytical result in pCi/L or µg/L, as determined above) of the composite sample that was in progress at the end of that day (specifically, at 23:59:59).
  - Each calendar day has an associated surface water volume (liters) that was measured by the flow meter. The flow record may contain estimated values for certain conditions.<sup>29</sup>
  - The daily surface water volume is then multiplied by the corresponding activity/concentration to calculate a load (in pCi, mg, or µg) for each day.
  - The sum of the daily loads (pCi, mg, or µg) for the preceding 30 days (with both flow and an analytical result) is divided by the sum of the daily surface water volumes (liters) for the preceding 30 days to calculate the volume-weighted 30-day average (pCi/L, mg/L, or µg/L). The equation can be given as follows:

$$\frac{\sum_{day=-29}^{day=0} [\text{picocuries or micrograms}]}{\sum_{day=0}^{day=-29} [\text{liters}]} = 30\text{day Average}_{day=0} [\text{pCi/L, mg/L, or } \mu\text{g/L}] \quad (\text{Equation 8-3})$$

- The 30-day average values are then rounded to two significant figures. No rounding occurs with the measured input numbers prior to calculation of the 30-day averages. Only the final calculated value is rounded. For example, a calculated value of 0.124 pCi/L would be rounded to 0.12 pCi/L. Similarly, a value of 0.246 pCi/L would be rounded to 0.25 pCi/L.
- These 30-day averages are then compared to the appropriate water quality standards according to the criteria in the applicable data evaluation flowcharts in RFLMA (Attachment A2).

### ***POC and POE 12-Month Rolling Averages***

Evaluation of analytical data using 12-month volume-weighted rolling averages is currently performed for the POE and POC monitoring objectives (radionuclides and nitrate only). The method is as follows:

- Rolling 12-month averages are calculated monthly for each location (on the last day of each month).
- Calculations are performed using daily time steps. The rolling 12-month average for a particular day (specifically the last day of each month) is calculated using a “window” of time that includes the previous 365 calendar days. Therefore, for a location with continuous flow and complete analytical results, 365 (366 in a leap year) daily values are included in each window (12 windows per year). For a location that flows intermittently,

<sup>29</sup> Estimation is required when flow rates exceed the capacity of the flow-control structure (e.g., a flume), winter ice conditions result in an inaccurate measurement, or there is an equipment failure.

the rolling 12-month window will include fewer than 365 daily values, because days of zero flow have no applicable analytical result or discharge volume.

- When no analytical result or measured flow value is available for a particular day, then the day is not included in the rolling 12-month window. No analytical result may be available either due to NSQ for analysis (Section 8.1.1) or a failed laboratory analysis. Flow measurement may also be missing due to equipment failures or adverse weather conditions (winter freezing).
- When a negative radionuclide result (e.g., -0.002 pCi/L) is returned from the laboratory due to blank correction, then a value of 0.0 pCi/L is used for calculation purposes. When a nondetect is returned from the laboratory for nitrate analyses, then one-half the detection limit is used for calculation purposes.
- When a sample has a corresponding duplicate or reanalysis (“re-run”), **AND** *neither* result is greater than the applicable water quality standard, **THEN** the value used in calculations is the arithmetic average of the values.
- When a sample has a corresponding duplicate or reanalysis (“re-run”), **AND** *either* result is greater than the applicable water quality standard, **THEN** an evaluation of the data pair is performed to determine the representativeness of the sample results.<sup>30</sup> The method for determining representativeness is given below.

#### ***Determining Representativeness for Nitrate***

1. The RPD for the data pair is calculated:

$$RPD(\%) = \frac{|R_1 - R_2|}{(R_1 + R_2)/2} * 100$$

where

(Equation 8-4)

$R_1$  = value of initial result

$R_2$  = value of duplicate result

- 2a. **IF** the RPD is greater than or equal to 100 percent ([higher result]  $\geq$  3x [lower result]), **THEN** the results will be determined to be nonrepresentative. The results will not be used for the calculation of 30-day averages, and no 30-day average values will be computed for the days during which the sample was collected.
- 2b. **IF** the RPD is less than 100 percent ([higher result]  $<$  3x [lower result]), **THEN** the results will be determined to be sufficiently representative. The arithmetic average of the results will be used for the calculation of 30-day average values.

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<sup>30</sup> Significant differences in values for a data pair are an indication of potential problems with sample preparation and/or analysis. Under these circumstances, an applicable value to be used for the calculation of 30-day averages cannot be determined with sufficient confidence to make compliance decisions. As such, an evaluation is required to assess the representativeness of the sample and its usability for compliance decisions.



## Determining Representativeness for Radionuclides

1. The DER for the radionuclide data pair is calculated:

$$DER = \frac{|R_1 - R_2|}{\sqrt{(2\sigma_{R1})^2 + (2\sigma_{R2})^2}}$$

where

$R_1$  = value of initial result

(Equation 8–5)

$R_2$  = value of duplicate result

$2\sigma_{R1}$  = 2 sigma error of initial result

$2\sigma_{R2}$  = 2 sigma error of duplicate result

- 2a. **IF** the DER is greater than or equal to 1.5, **THEN** the results will be determined to be nonrepresentative. The results will not be used for the calculation of 12-month rolling averages.
- 2b. **IF** the DER is less than 1.5, **THEN** the results will be determined to be sufficiently representative. The arithmetic average of the results will be used for the calculation of 12-month rolling average values.
  - Each calendar day is assigned the activity (analytical result in pCi/L or mg/L) of the composite sample that was in progress at the end of that day (specifically, at 23:59:59).
  - Each calendar day has an associated surface water volume (liters) that was measured by the flow meter. The flow record may contain estimated values for certain conditions.<sup>31</sup>
  - The daily surface water volume is then multiplied by the corresponding activity to calculate a load (in pCi or mg) for each day.
  - The sum of the daily loads (pCi or mg) for the preceding 365 calendar days (with both flow and an analytical result) is divided by the sum of the daily surface water volumes (liters) for the preceding 365 calendar days to calculate the 12-month rolling average (pCi/L or mg/L). The equation can be given as follows:

$$\frac{\sum_{day=-364}^{day=0} [\text{picocuries or micrograms}]}{\sum_{day=0}^{day=-364} [\text{liters}]} = \text{Rolling 12 - Month Average}_{day=0} [\text{pCi/L or mg/L}]$$

where

$day = 0$  is the last day of each month

(Equation 8–6)

- The 12-month rolling average values are then rounded to two significant figures. No rounding occurs with the measured input numbers prior to calculation of the 12-month rolling averages. Only the final calculated value is rounded. For example, a

<sup>31</sup> Estimation is required when flow rates exceed the capacity of the flow-control structure (e.g., a flume), winter ice conditions result in an inaccurate measurement, or there is an equipment failure.

calculated value of 0.124 pCi/L would be rounded to 0.12 pCi/L. Similarly, a value of 0.246 pCi/L would be rounded to 0.25 pCi/L.

- These 12-month rolling averages are then compared to the appropriate water quality standards according to the criteria in the applicable data evaluation flowcharts in RFLMA (Attachment A2).

## 8.3 Data Management

LMS is responsible for managing and maintaining the electronic monitoring data and geospatial data in compliance with DOE-LM requirements. Environmental monitoring data are produced mainly from sampling and automated monitoring systems.

Electronic or hard-copy field-data books and forms are assembled for all sampling events, recording relevant data for tracking purposes. These data are kept on file.

Data will be accessible over the Internet at [www.lm.doe.gov](http://www.lm.doe.gov) through GEMS. Spatial data in GEMS include physical features and roads, nonphysical features such as the Site boundary and access control boundaries, and imagery such as orthorectified aerial photography and satellite imagery.

### 8.3.1 Water Data

Data from samples submitted to an analytical laboratory are received as both hard copy and as an electronic data deliverable. The electronic data are loaded into an Oracle<sup>®</sup>-based relational database, which also contains historical monitoring data for RFP/RFETS. The environmental monitoring data are accessible using SEEPro. The hard-copy analytical reports are archived in the Site records library in Grand Junction, Colorado. The original field data forms and other relevant hard-copy forms or documents containing project data are archived in the Rocky Flats Site Central Files at the Westminster, Colorado, offices. Well construction and lithology logs are maintained for previously drilled wells and are produced for all new wells drilled. These logs are archived in the Site records library and can also be accessed electronically via the SEEPro database and GEMS.

SEEPro uses Oracle<sup>®</sup> software for data management and Microsoft<sup>®</sup> Access for data retrieval and display. It compiles water quality, air quality, field parameter, sample tracking, sample location, and water level data for groundwater, surface water, boreholes, soils, and sediment samples. Field parameter data include such information as sample location, sample date, pH, turbidity, conductivity, and temperature. Chemical information (e.g., Chemical Abstracts Service registry numbers, analytical results, and detection limits) is also included.

Specific procedures for verification of database information received from subcontractors, or input directly into SEEPro, are followed. These procedures provide QA documentation, which ensures that available data have been incorporated and entered or uploaded properly into SEEPro. Data integrity is maintained with standardized error checking routines used when loading data into SEEPro. Other procedures address database system security and software change control.

Where generated, hard copies of the Site field data are entered through the FieldPar field data entry system. This system is a data entry module that is compatible with the SEEPro database, and is used in the office by field personnel. Data entered into FieldPar are verified by the sampler before loading into the main SEEPro database. An electronic field data collection system has been implemented at the Rocky Flats Site and has replaced hard-copy field forms for some activities (e.g., groundwater sampling and water-level measurements). Data collected with the electronic Field Data Collection System are automatically uploaded into FieldPar when the sampler uploads the collected data at the end of each sampling day.

Spatial information for Site features is located in the GIS database. Some of the data features included are monitoring locations, potentiometric surfaces, plume configurations, streams/creeks, lakes/ponds, topographic contours, and historic RFP/RFETS facilities. This system uses an ESRI® ArcGIS™ suite of software to store and present data. Automated monitoring locations and other sample location data features are derived from location information stored in the SEEPro database.

### **8.3.2 Ecology**

Ecological data have been collected at Rocky Flats for many years. Since the early 1990s ecological data have been kept in electronic files for easier access, retrieval, and analysis. In the mid-1990s, the Sitewide Ecological Database (SED) was established as a master dataset for the various types of ecological data collected at the Site. The SED is a Microsoft Access® database that contains all quality-assured ecological data for RFETS from early 1993 through the end of 2001. The SED is located on the “Robin” server at the Rocky Flats office in Westminster, Colorado. Data that did not meet the QA objectives are not included in the database. Ecology data in the SED include historical vegetation monitoring, weed control and controlled burn vegetation monitoring, wildlife surveys (including birds, small mammals, frogs, insects, and fish), Preble’s mouse habitat characterization and telemetry tracking, a small amount of soil characterization survey data (for revegetation issues), and a few other types of ecological data. The SED does not contain data on potential contaminants nor is it linked to any GIS or other spatial tool. Data in the SED are primarily observational or catch-and-release (e.g., small mammal or fish sampling); they are raw data taken directly from field logbooks and datasheets. The SED is not intended as a reference for the layperson. It is a repository of quality-assured raw field data collected by Site ecologists and should not be taken out of context of the methods used to collect the data. Data collection methods are not stored in the database; they are described in reports and field sampling plans.

From 2002 to the present, ecology data have been stored as separate datasets by sample type, event, and year. Depending on the dataset, the data may be in a Microsoft Access® database or a Microsoft Excel® spreadsheet format. The nonspatial electronic ecology data are stored on the “Robin” server at the Rocky Flats office in Westminster, Colorado, or on backup electronic media.

Spatial ecology data for the Site are available for several data types and are stored in GIS on the “Gull” server in Grand Junction, Colorado. The types of ecological spatial data that are available include annual weed distribution data (for select species), annual weed control locations, biocontrol release locations, vegetation and wildlife monitoring locations (transect endpoints and sample points), vegetation community classifications, revegetation project locations, wetland

locations, wildfire/prescribed burn locations, Preble's mouse habitat, Preble's mouse and wetland mitigation work, and rare plant locations. These data are available in various ArcGIS®-compatible formats. In addition to these types of spatial data, orthorectified aerial and satellite imagery of the Site is also available for different timeframes (pre- and post-closure).

### ***Historical Ecology Information for Rocky Flats***

A master reference list of reports that contain information on the ecology of Rocky Flats is maintained by the Ecology Program (Attachment E1). The reference list contains documents dating back to the 1970s. Most of these documents have been scanned and are available electronically. Additionally, a variety of historical hard-copy aerial photographs of the Site are available that may be used for ecological evaluations. Electronic aerial and satellite imagery is also available through the GIS. Although a large amount of ecological information about the Site is available through the Ecology Program, additional information may be found in the federal archives through the Records Group.

## **8.4 Data QA/QC**

### **8.4.1 QC Objectives for Collection of Water Data**

General requirements for water monitoring activities are covered under the *Legacy Management CERCLA Sites Quality Assurance Project Plan* (LMS/PLN/S04353) (QAPP). The QAPP is consistent with the QA Program requirements of DOE Order 414.1C, *Quality Assurance* (DOE 2005); environmental data operation requirements in EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 2001b); and American National Standards Institute/American Society for Quality (ANSI/ASQ) E-4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ 2004). The QA Program covers environmental activities and describes the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. The SAP presents the methods by which water monitoring is performed at the Site. Nonroutine evaluations and special sampling projects will be governed by task-specific work plans, SAPs, or other work control documents (Section 9.0).

The QAPP generally covers QC for the following components of the surface water and groundwater programs:

- Collecting and analyzing samples according to approved procedures; and
- Reducing, reporting, and managing data and records in a controlled manner.

QC objectives for the collection of field parameters and representative samples of groundwater are established to ensure that data are of sufficient quality to support the decisions identified in the previous section. The fundamental QC objectives for field data collection are the following:

- Sampled water is representative of UHSU groundwater.
- Sampling techniques do not introduce contaminants into samples or wells.

- Sampling techniques are generally standardized for improved reproducibility and comparability of results.
- Water elevations are measured precisely enough to detect minor fluctuations ( $\pm 0.01$  foot) in the water table.

QC objectives for the collection of field parameters and representative samples of surface water are established to ensure that data are of sufficient quality to support the decisions identified in the previous section. The QC objectives for field data collection are the following:

- Sampled water is representative of surface water.
- Sampling techniques do not introduce contaminants into samples.
- Sampling techniques are generally standardized for improved reproducibility and comparability of results.
- Water levels are measured precisely enough to detect minor fluctuations (approximately  $\pm 0.005$  foot) in flow.

The SAP and this RFSOG are followed to ensure that quality samples are collected for use in environmental decision making.

QC samples typically consist of field duplicates and equipment blanks (also known as equipment rinse or rinsate samples); trip blanks may also be collected. Field duplicates and equipment blanks are generally collected at a frequency of 1 each for every 20 real samples. Trip blanks, which are only analyzed for VOCs, may be collected at a rate of one per shipment of samples to be analyzed for VOCs.

Field duplicates will be collected using the exact same methods and equipment as real samples (“FIELD SAMPLE” in SEEPro). These samples provide information on overall precision, reflecting the cumulative effects of field and laboratory precision. The typical procedure is to collect a real and field duplicate sample at the same time, by filling the real sample bottle part way, then the field duplicate bottle the same amount, then the real bottle, and so on. Unless instructed otherwise, bottles may be filled one-third or one-half at a time. Note that this manner of filling bottles partway does NOT apply to samples to be analyzed for VOCs; instead, due to concerns regarding volatilization, VOC samples will be completely filled in one pass.

Equipment blank samples are collected following completion of sampling and decontamination at a given location. These samples provide an indication of cross-contamination resulting from inadequate decontamination methods. The freshly decontaminated equipment used to collect a real sample is rinsed with distilled or deionized water. That water is then poured into sample bottles for analysis of the same suite of constituents as the real sample. Equipment blank samples are not filtered. Collecting equipment blank samples at a well equipped with a dedicated bladder pump is not practicable, as it would require removal and decontamination of the pump, then pumping deionized or distilled water into the sample bottles.

Equipment blank samples for the automated surface water locations are prepared by filling a reusable composite sample carboy<sup>32</sup> with distilled or deionized water. The carboy water is then

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<sup>32</sup> Composite carboys are reused for automated sampling. The carboys are dedicated to a specific location.

poured into sample bottles for analysis of the routine suite of constituents for a given location. Carboy blank samples are not filtered.

Trip blanks may be collected to assess the potential for cross-contamination during sample handling and shipping, from packaging at the Site shipping office to analysis at the laboratory. Blank samples may be prepared using deionized or distilled water and placed within the sample cooler as it is packed with other samples for VOC analysis. The trip blank will be handled in the same manner as all other VOC samples in that batch.

QC samples will be shipped “blind” to the laboratory, with no indication of the source of water or the QC objectives of the sample. Sources of distilled and deionized water will be reputable and will supply complete analytical results for each batch of water received. These results will be reviewed whenever QC sample results show unexpected detections that may be attributable to this source water.

In the case of equipment rinse samples, a comparison with the source water analysis will indicate whether the water itself may be the cause of any contaminants that may be reported in these rinse samples. For equipment rinse samples collected to support groundwater samples and surface water grab samples, a comparison with the results for the real (FIELD in SEEPro) samples that were collected immediately prior to the collection of those equipment blanks is also appropriate, as the presence of contaminants in a rinse blank may be due to inadequate decontamination at that location. If the latter is suggested, field personnel will improve their attention to detail and more thoroughly decontaminate sampling equipment following completion of sampling at each location. If the source water is suggested as the cause of the detections, potential sources of the contaminants that are not attributable to the source water itself (e.g., contaminants in a trip blank resulting from the use of solvents in the sample prep room) will be evaluated. Where this is not applicable and the source water supply is the most reasonable suspect for the source of the contamination, alternatives include securing an alternate source of water and discussing necessary improvements with the water supplier; failure to correct the condition will require that an alternate source of water be secured.